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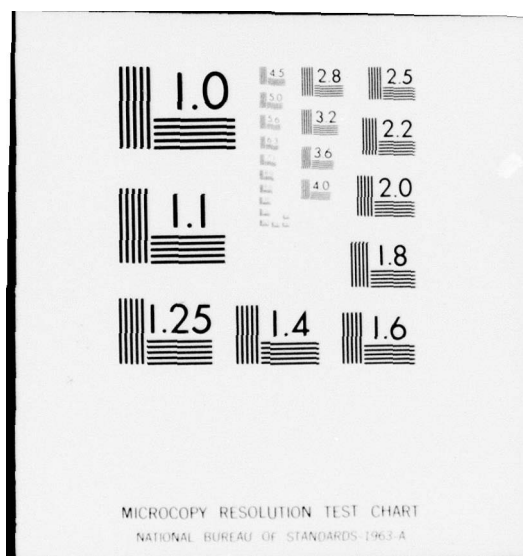
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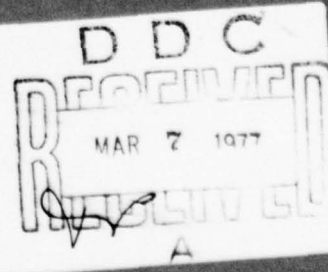
Seafarer Site Survey Upper Michigan Region

for
U.S. Navy
Naval Electronic Systems Command
Washington, D.C.

by
EDAW inc.
under contract to
GTE Sylvania
Communication Systems Division

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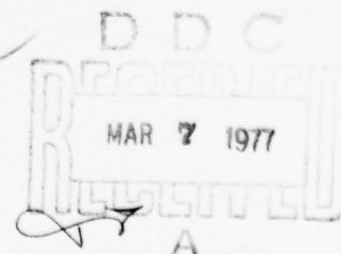
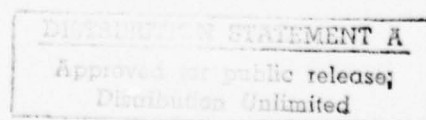
UTILITIES DATA
of the
UPPER MICHIGAN REGION
PROJECT SEAFARER

for
U. S. Navy. Naval Electronic Systems Command

by
EDAW, Inc., 50 Green Street, San Francisco 94111

Under Contract to
GTE Sylvania, Communication Systems Division ✓

April, 1976



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SUMMARY

Information on utility systems and other long conductors has been collected for the Study Area and, within Michigan, an adjacent 10-mile fringe area. All data and tables in this narrative include the Study Area and the 10-mile fringe area. Utility systems and other long conductors discussed include: electrical transmission and distribution systems, telephone systems, pipelines, railways, special purpose mission-related long conductors and metallic fences.

Six electric power companies or co-ops serve the Study Area (Figure 1). The two largest power companies providing service are Wisconsin Michigan Power Company (WMPC) and Upper Peninsula Power Company (UPPC). Together, they generate approximately 484 MW (90 percent) of the electrical energy used within the Study Area. Marquette Board of Light and Power also has a generating capacity of 57.2 MW bringing the total energy generated and used within the area to approximately 541.2 MW. The remaining three companies purchase their electrical energy for resale primarily from WMPC or UPPC.

It is estimated that WMPC has approximately 2,264 miles and UPPC has 2,276 miles of transmission and distribution lines in the Study Area. The four other power companies within the area have 851 miles of lines bringing the total to approximately 5,391 miles, not including short lines or drops less than 300 feet in length.

The Study Area telephone system has 37 central offices and approximately 800 route miles of open wire line and 2,200 sheath miles of telephone cable.

Several major metal pipelines in the area transport petroleum products and natural gas. They range in size from 2-inch diameter to 36-inch diameter, with a total of approximately 550 miles of pipeline within the Study Area.

There are six commercial railroads in the Study Area with a total track length of approximately 750 miles. These are freight lines, with different types of communication systems along their routes. Railroads are also discussed in the Transportation Data Report and are shown on the Transportation Data Map (Book 7).

Fences are most numerous in agricultural regions within the Study Area. They are usually three or four strands of barbed wire in lengths of a few hundred to a few thousand feet. The most substantial fences are associated with

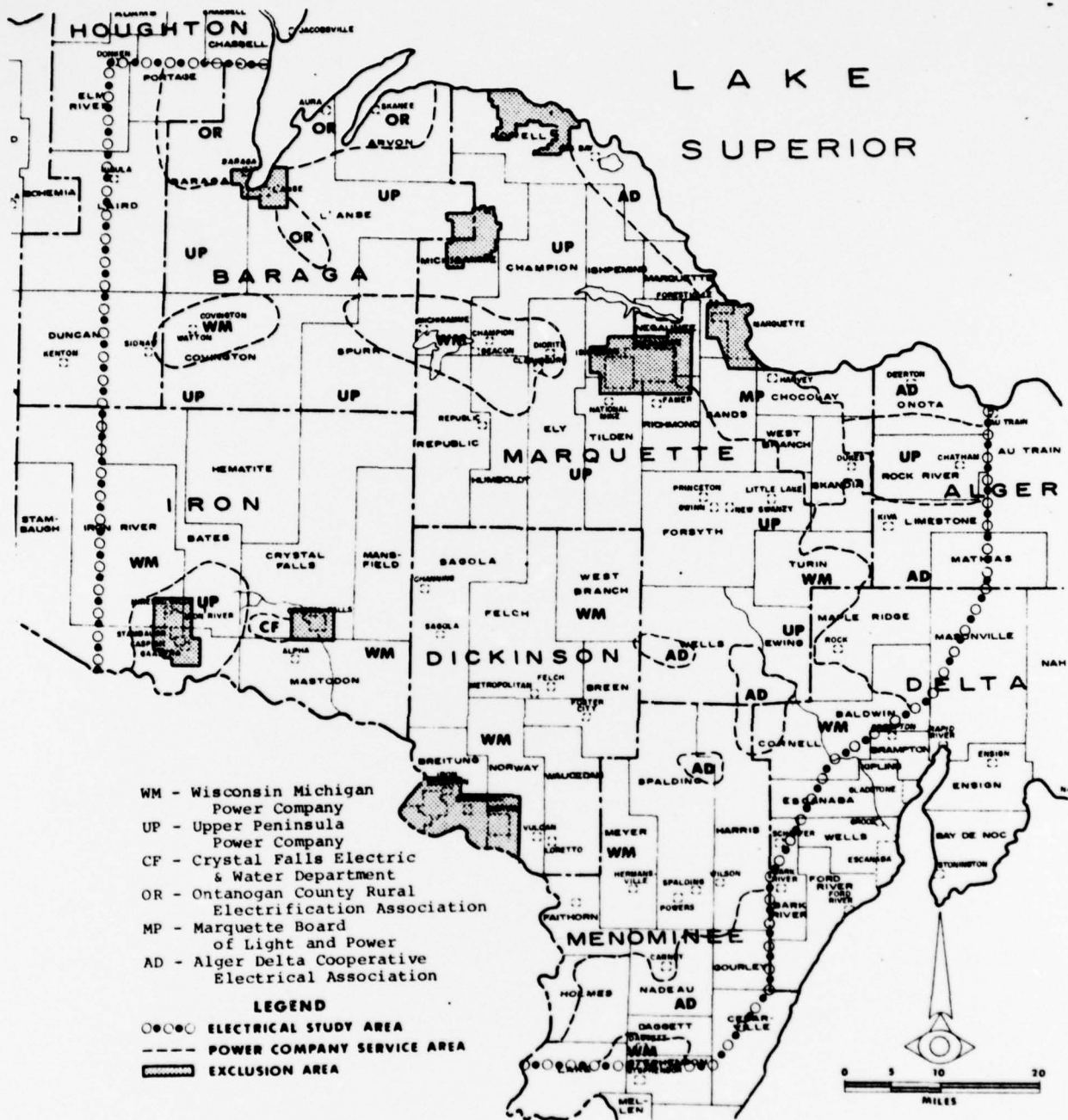


Figure 1. POWER COMPANY SERVICE AREAS

Source: Williams & Works (March 5, 1976)

institutions and mining areas. Also, highways have many sections equipped with steel guard rails or cables up to 1,000 feet long.

Other long conductors in the Study Area include utility lines and tracks in active mines, utility lines at K. I. Sawyer Air Force Base, coaxial cable for TV signal distribution, and steel cables associated with ski lifts.

EVOLUTION

Anticipated Future Conditions

Electrical Transmission and Distribution Systems

The Upper Peninsula Power Company has seven new 138 kV lines under construction. They are also proposing to rebuild an existing 69 kV line from Houghton to provide 138 kV service and to construct a White Pine line and substation to serve the new line. These are shown on the Utilities Data Map.

The Upper Peninsula Power Company is also planning to build an 80 MW plant by 1980 in the Houghton-Hancock area. The type of fuel to be used has not been determined as yet. The Cliffs Electrical Service Company is also studying various sites for a 500 MW coal-fired plant. Three 80 MW coal-fired units are under construction by UPPC for completion in 1978.

The Wisconsin Michigan Power Company had no information readily available on projected time-phased growth of additional support facilities.

The Marquette Board of Light and Power has plans to build a 43 MW coal-fired steam turbine generating plant. It is expected that this generating facility will be in operation by approximately 1980 and will provide approximately 25 percent of its load to areas outside the city. The Marquette Board of Light and Power also plans to extend 69 kV lines to loop the city. A new substation is also planned on the west side of the city (69 kV to 12.5 kV) with a tentative capacity of 12,000 kVA.

The Crystal Falls Electric and Water Department is currently changing the distribution voltage from 2,400 volts to 12,400 volts. No indication has been given for additional support facilities.

The Ontonagon County Rural Electrification Association's existing lines are carrying approximately 80 to 90 percent of their maximum load. The REA plans to change lines in the Aura area from 7.2 kV to 14.4 kV and convert some single phase lines to three phase.

Company officials of Alger Delta Cooperative Electrical Association estimate a normal expansion of the entire system at approximately 10 percent annually.

Telephone Systems

The Huron Mountain exchange area recently assigned to the Upper Peninsula Telephone Company will not have complete plans until approximately October 1976. The initial phase will include approximately 100 miles of cable lines.

Michigan Bell, the largest telephone company in the Study Area, estimates a plant growth rate of approximately one percent per year in the area. There will be no new open wire construction. Increased capacity for local service will generally be provided by additional buried cable following existing service routes. Trunk line routes requiring additional capacity will be supplemented by radio-relay rather than by additional cable.

Based on system planning maps for Midway Telephone Company it is expected that their plant will be virtually all buried cable by 1980, with approximately a 12 percent increase in total miles of line within the period 1975 to 1980.

Pipeline Systems

There are no indications by the major pipeline companies in the Study Area of any major expansion in the future.

Railway Systems

The expansion of mining activity in the Upper Peninsula has had a significant impact on the railroad lines operating in the region. According to the Michigan Railroad Plan, Phase II Report, every railroad line in the Upper Peninsula is solvent, and this is the only region that has no railroad lines affected by the Railroad Reorganization Act of 1973. The entire Upper Peninsula has only three pending abandonment cases. The only line within the Study Area petitioned for abandonment is the Chicago, Milwaukee, St. Paul and Pacific Railroad's Republic-Champion line. Just to the east of the Study Area, the Soo Line's Rapid River-Eban Junction line has been petitioned for abandonment.

DISTINCTIVE UNITS AND CHARACTERISTICS

The Utilities Data Map depicts the electrical transmission and distribution systems, telephone systems and pipelines. The railways have been shown on the Transportation Data Map. All incorporated areas with a population of 2,000 or more, plus a buffer zone of one mile, are excluded from detailed study although some transmission lines have been shown in these areas for the sake of continuity. Other areas excluded from the study are the Huron Mountain Club and the McCormick Experimental Forest.

Electrical Transmission and Distribution Systems

The electrical power network within the Study Area and surrounding fringe area closely approximates the rural road pattern and utilizes the public road rights-of-way. The Utilities Data Map shows the operating plants, switching and substations. The routes with transmission lines (69kV to 138 kV), three phase distribution lines (7.2 kV to 33 KV) single phase distribution lines and underground lines are identified. There are few underground lines in the Study Area and there is no indication that the number of underground lines will significantly increase in the future.

There are six major power companies who provide electrical utility service within the Study Area and whose systems are delineated on the Utilities Data Map. They are as follows: Upper Peninsula Power Company (UPPC), Wisconsin Michigan Power Company (WMPC), Marquette Board of Light and Power (MBL&P), Crystal Falls Electric and Water Department (CFE&WD), Alger Delta Cooperative Electrical Association (ADCEA), and Ontonagon County Rural Electrification Association (OCREA).

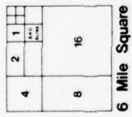
The two largest power companies providing service in the Study Area are Wisconsin Michigan Power Company (WMPC) and Upper Peninsula Power Company (UPPC). Together, they generate approximately 484 MW (90 percent) of the electrical energy used within the Study Area. Marquette Board of Light and Power also has a generating capacity of 57.2 MW bringing the total energy generated and used with the area to approximately 541.2 MW. The remaining three companies purchase their electrical energy for resale primarily from WMPC or UPPC.

Wisconsin Michigan Power Company generates all Upper Peninsula electrical energy with hydro units while Upper Peninsula Power Company generates 92 percent with coal-fired steam units, 2.6 percent with diesel oil fired units, and 5.4 percent with hydro units.

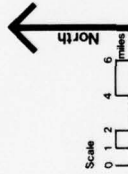
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Washington, D.C.



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UTILITIES

ELECTRICAL TRANSMISSION AND DISTRIBUTION SYSTEM

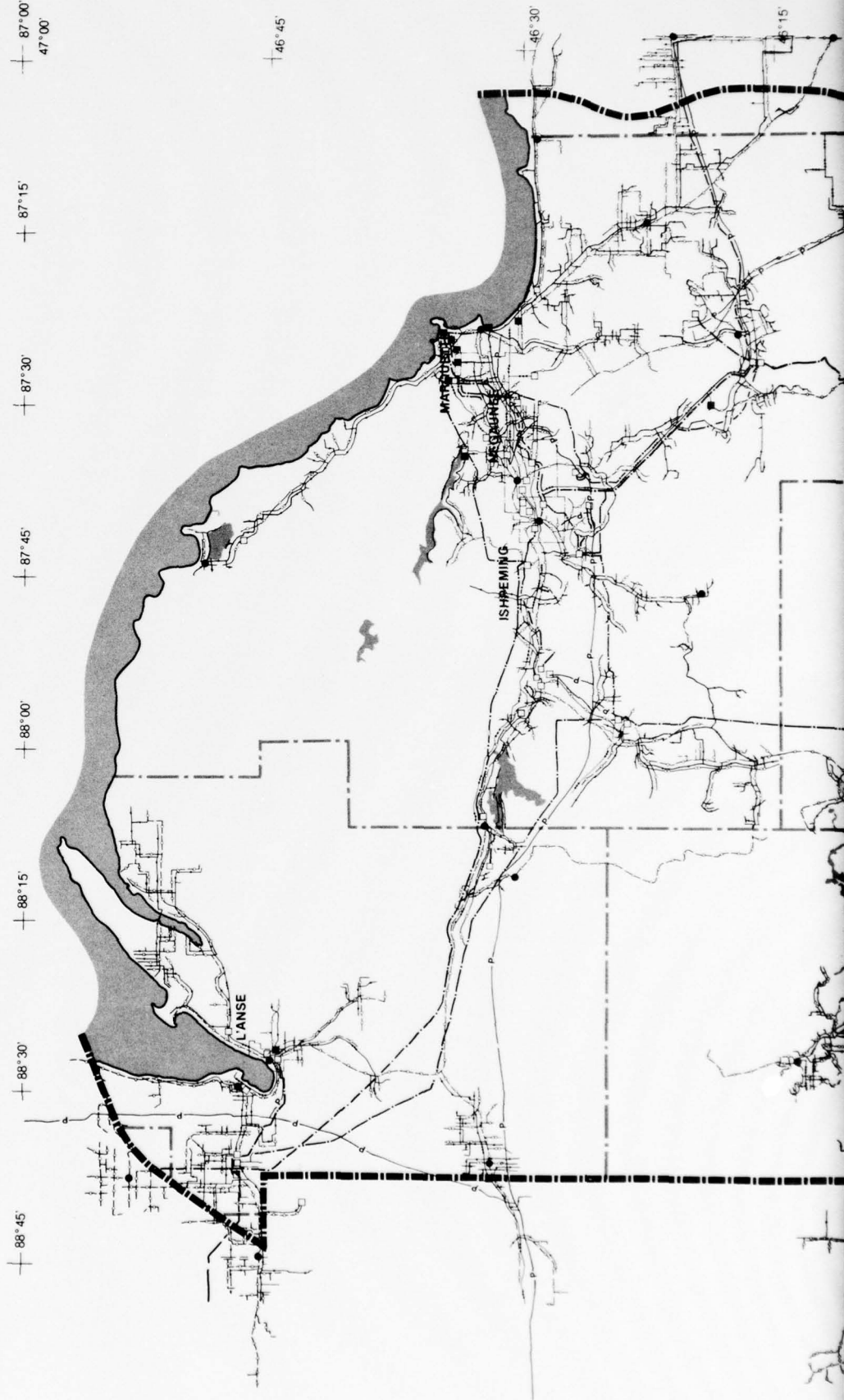
Transmission Line (69kV-138kV)
Three Phase Distribution Line (12.5kV-33kV)
Single Phase Distribution Line
Underground Line
Substation
Switching Station
Generation Station

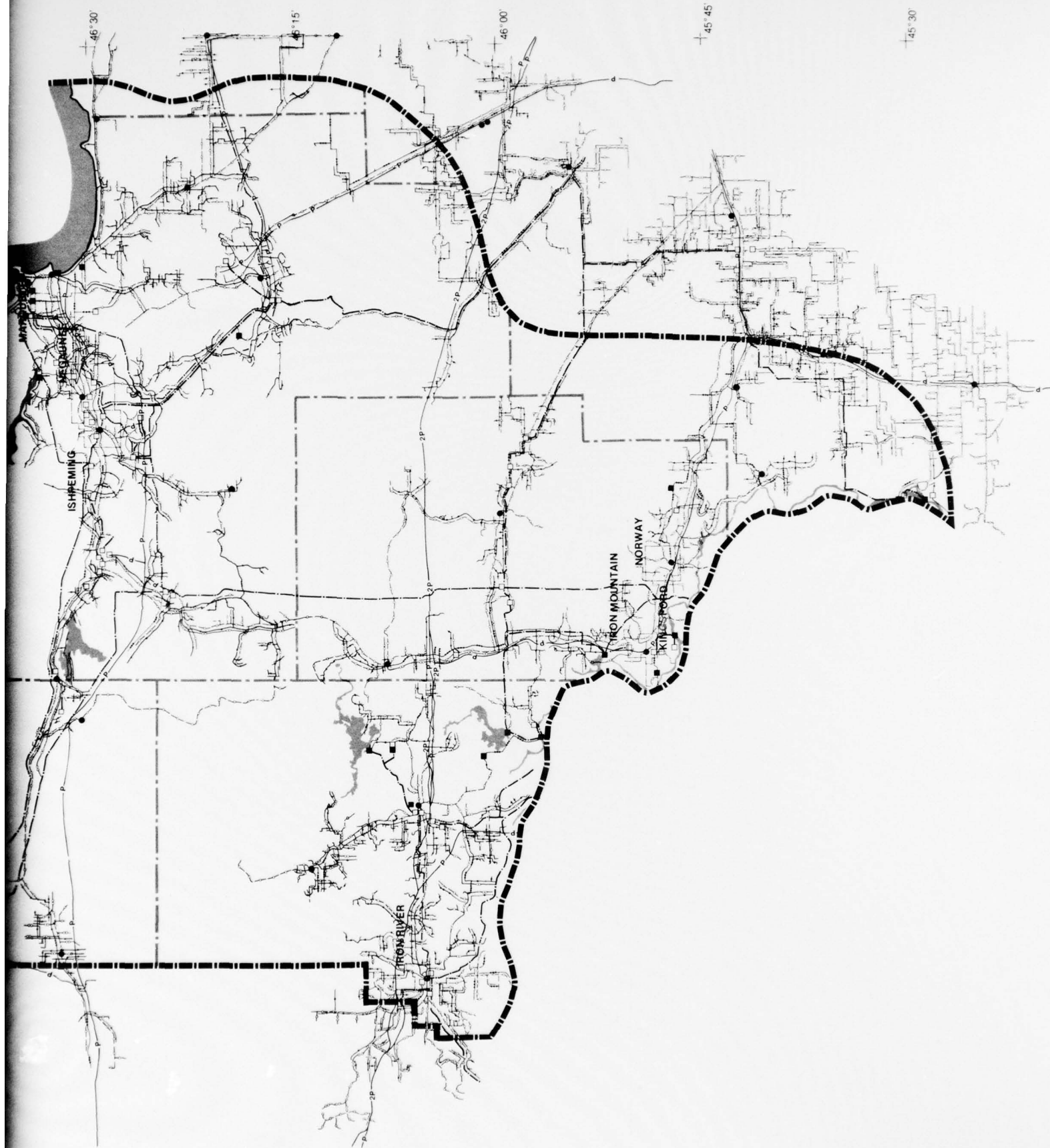


PIPELINES
One Line
Two Lines
Three Lines

TELEPHONE SYSTEM

Underground Cable
Open Wire
Aerial Cable
Central Office





It is estimated that WMPC has approximately 2,264 miles and UPPC has 2,276 miles of transmission and distribution lines in the Study Area. The four other power companies within the area have 851 miles of lines bringing the total to approximately 5,391 miles, not including short lines or drops less than 300 feet in length.

Upper Peninsula Power Company (UPPC)

The Upper Peninsula Power Company provides service to 95 communities and adjacent areas and furnishes energy for resale to four municipalities and three other electric utility companies in the Upper Peninsula. This includes most of the northern and central portions of the Study Area.

The Upper Peninsula Power Company has a widespread system utilizing 138 kV, 69 kV and 33 kV transmission voltages.

The Upper Peninsula Power Company has 2,276 miles of transmission and distribution lines in the Study Area.

Wisconsin Michigan Power Company (WMPC)

Although the main headquarters of Wisconsin Michigan Power Company are located in Milwaukee and Appleton, Wisconsin, the service area extends throughout east central and northern Wisconsin and into the Upper Peninsula of Michigan. Power service is provided in the south central portion of the Upper Peninsula primarily in Iron and Dickinson Counties.

In the Upper Peninsula, Wisconsin Michigan Power Company power is all produced by hydro plants on the Menominee, Brule, Pine, Sturgeon, Michigamme and Paint Rivers. Some power could be provided by the Point Beach Nuclear Plant located to the south in Wisconsin.

Although the total system load is currently 439,000 KW, only 95,362 KW is utilized in the Study Area.

Within the Upper Peninsula, Wisconsin Michigan Power Company develops its power primarily on the Brule and Menominee Rivers on the border between Michigan and Wisconsin. Power is generated at 480 V, 2.3 kV, 4.16 kV, 6.6 kV and 6.9 kV and stepped up to 69 kV for transmission throughout the area. In limited areas, the 7.2 kV, 12.47 kV or 13.8 kV distribution system is utilized for transmitting outputs from hydro generating stations.

Within the Study Area, Wisconsin Michigan Power Company has 2,264 miles of both transmission and distribution lines.

Marquette Board of Light and Power (MBL&P)

The Marquette Board of Light and Power services the entire City of Marquette and a large area adjacent to the City in all directions.

Within the Study Area, Marquette Board of Light and Power has 191.6 miles of both transmission and distribution lines.

Ontonagon County Rural Electrification Association (OCREA)

The Ontonagon County REA serves three portions of the rural area in the western part of the Study Area. The Ontonagon County REA is interconnected with and purchases all electrical energy from the Upper Peninsula Power Company and the Wisconsin Michigan Power Company.

Within the Study Area, Ontonagon County Rural Electrification Association has 141 miles of 7.2 kV/12.5 kV transmission and distribution lines.

Alger Delta Cooperative Electrical Association (ADCEA)

Alger Delta is a Rural Electrification Association Co-op serving a large portion of the rural area in the south and eastern portions of the Study Area. The Co-op purchases all electrical energy from Wisconsin Michigan Power Company, Upper Peninsula Power Company, and Marquette Board of Light and Power.

Within the Study Area, Alger Delta Cooperative Electrical Association has 488 miles of 7.2/12.5 kV transmission and distribution lines.

Crystal Falls Electric and Water Department (CFE&WD)

The Crystal Falls Electric and Water Department primarily serves areas within the City of Crystal Falls; however, they do extend service to a large rural area to the west of the City.

Within the Study Area, Crystal Falls Electric and Water Department has 30 miles of 2.4 kV and 12.5 kV transmission and distribution lines.

Rights-of-Way

Except in rare cases where property has been deeded to or is owned by the power companies, the transmission and distribution lines are located in easements or road Rights-of-Way. The transmission lines of the Upper Peninsula Power Company are generally on easements of approximately 100 to 110 feet in width. Approximately ten percent are owned Rights-of-Way. Nearly all distribution lines are on public Rights-of-Way. When this is not possible separate easements are obtained from individual property owners. Other lines are on co-use right-of-way arrangement with local telephone companies. The Wisconsin Michigan Power Company's 69 kV transmission lines are generally located within 100-foot easements. Distribution lines at 13.8 kV and lower voltages are generally located in road Rights-of-Way or in trim easements 15 feet on either side of the transmission line.

Marquette Board of Light and Power's and Crystal Falls Electric and Water District's transmission lines are generally on public road Rights-of-Way. Some distribution lines of MBL&P are on private property with 20-foot easements. In some areas these power companies share poles with telephone companies.

In Baraga County, which Ontonagon County Rural Electrification Association services, all transmission and distribution lines are 34 feet off the centerline of road Rights-of-Way, or approximately one foot outside the public road Rights-of-Way on private property. The Alger Delta Co-op's lines are located in the same procedure.

Power Generation Plants

The six major power companies that serve the Study Area have 28 generating stations within the Study Area. The names and locations of the stations are given in Table 1. The Wisconsin Michigan Power Company, which has the majority of stations in the Study Area, develops its power primarily on the Brule or Menominee Rivers on the border between Michigan and Wisconsin. Power is generated at 480 kV, 2.3 kV, 4.16 kV, 6.6 kV and 6.9 kV, and stepped up to 69 kV for transmission throughout the area. In limited areas, 7.2 kV, 12.47 kV or 13.8 kV is also used as a transmission voltage.

The Plains substation, located west of Norway, Michigan on the Menominee River, carries power at 138 kV. This power is generated at the Point Beach Nuclear Plant to the south in Wisconsin and carried on three circuits on two high voltage tower lines to the Plains substation where it is stepped

Table 1. GENERATING PLANTS SERVING POWER TO THE STUDY AREA

Name	Location	Capacity (KW)	Fuel	*Utilization
<u>Upper Peninsula Power Company</u>				
J. H. Warden Station	L'Anse	15,625	Coal	80%
Prickett Hydro Station	Baraga County	2,200	Hydro	75%
Ishpeming Station	Ishpeming	7,500	Coal	92%
Ishpeming Station (CCI)	Ishpeming	10,000	Diesel	80%
Hoist Hydro Station	Dear River Storage	4,400	Hydro	75%
McClure Hydro Station	Marquette Twp.	8,000	Hydro	75%
Cataract Hydro Station	Forsyth Twp.	2,000	Hydro	75%
Carp Hydro Station (CCI)	Marquette	4,400	Hydro	75%
Presque Isle Station (CCI)	Marquette	334,700	Coal	89%
+Escanaba Station	Escanaba	25,300	Coal	87%
+Au Train Hydro Station	Au Train	896	Hydro	75%
+Portage Station	Adams Twp.	55,000	Fuel Oil	80%
+Dodgeville Station	Dodgeville	9,080	Fuel Oil	80%
+Victoria Station	Victoria Dam	12,000	Hydro	75%
<u>Wisconsin Michigan Power Company</u>				
Twin Falls	Twin Falls, MI.	6,490	Hydro	60- 95%
Brule	Mastadon, MI.	6,666	Hydro	47- 75%
Pine	Florence, WI.	4,000	Hydro	50-100%
Sturgeon	Loretto, MI.	1,000	Hydro	80%
Big Quinnesec Falls	Iron Mountain, MI.	17,778	Hydro	79-100%
Chalk Hill	Amberg, MI.	9,750	Hydro	42- 68%
White Rapids	Amberg, MI.	10,000	Hydro	60- 86%
Peavy Falls	Randville, MI.	15,000	Hydro	93-100%
Way	Crystal Falls, MI.	1,800	Hydro	0-100%
Michigamme Falls	Florence, MI.	10,667	Hydro	80- 88%
Hemlock Falls	Crystal Falls, MI.	3,111	Hydro	32- 84%
Lower Point	Crystal Falls, MI.	100	Hydro	100%
**Kingsford	Kingsford, MI.	9,000	Hydro	55- 68%
+Point Beach	Wisconsin	1,000,000	Nuclear	-
<u>Crystal Falls Electric and Water Department</u>				
Point River	Crystal Falls	--	Hydro	-
<u>Marquette Board of Power and Light</u>				
#2 Hydro Station	Dead River/Wright St.	3,000	Hydro	70%
#3 Hydro Station	Dead River/CR 550	700	Hydro	70%
#4 Diesel Station	Dead River/CR 550	15,000	Diesel Oil	60%
#5 Shiras Station	Foot of Hampton St.	38,000	Diesel Oil	60%
* Variations based on monthly low to high flows within a dependable range over a 30-year record.				
** Switching only.				
+ Not located within the Study Area				

down to 69 kV and 13.8 kV for transmission in the area. Power is also carried through the substation at 138 kV continuing northerly to the Nordic interconnection with the Upper Peninsula Power Company located three miles west of Felch, Michigan. Data on major substations is included in Appendix A.

K. I. Sawyer Air Force Base

Electrical power is provided to Sawyer Air Force Base by purchase contract with Upper Peninsula Power Company.

The UPPC main is a 69 kV, 3 phase, three-1/0 ACSR wire feeding the power company owned transformers in the Government owned main substation at the southeast corner of the base near the sewage treatment plant. The feeder connects with the Upper Peninsula Power Company's Gwinn substation five miles away. Installed in the base substation are two 5,000 kVA Delta to Wye transformers which reduce the supply voltage to 7,200/ 12,470 volts. These transformers have a 7,000 kVA forced-air capacity. Seven 1,200 amp power circuit breakers (one main and six feeder breakers) limit the load on the transformers. Six fused disconnects and two air break switches are also installed at the station. The Power Company owns all equipment up to the voltage regulator. Three main feeders, two of four-2 ACSR size and one of four-2/0 ACSR size, furnish power to the distribution network on the base area. Three-four wire feeds (one-2/0, one-1/0 and one-4/0 ACSR) serve the Capehart housing area. Except in the airfield area, all feeders are carried overhead on poles. The airfield area is provided with an underground duct and manhole system. The general condition of wire, poles, and transformers is good and apparently adequate to meet base needs.

Emergency power is available at the base in the form of 30 fixed and portable power units.

Telephone Systems

The Utilities Data Map shows the telephone plant central offices and routes, with open-wire lines, buried cable, and aerial cable identified. Open-wire lines are quite scarce. The plant is predominantly buried cable, and this trend will continue in the future.

The Study Area, including the ten-mile periphery is served by six telephone companies: Michigan Bell Telephone, Midway Telephone, Baraga Telephone, Chatham Telephone, Upper Peninsula

Telephone, and General Telephone Company of Michigan. They are responsible for the following exchanges within and adjacent to the Study Area:

Michigan Bell

Amasa	Iron River
Bark River	Ishpeming
Big Bay	Marquette
Champion	Michigamme
Channing	Negaunee
Cornell	Norway
Crystal Falls	Powers
Escanaba	Rapid River
Gladstone	Republic
Gwinn	Rock-Perkins
Hermansville	Stephenson
Iron Mountain	

Midway

Golden Lake
Trout Creek
Watton

Baraga

Alston
Baraga
Tapiola

Upper Peninsula

Carney
Faithorn
Felch
Fench River
Huron Mountain
Michigamme Forest
Watson

Chatham

Au Train
Chatham
Skandia
Trenary

General Telephone

L'Anse

The Huron Mountain exchange area, in the northern portion of the Study Area, has only recently been assigned to the Upper Peninsula Telephone Company, and plans will not be complete until approximately October 1976. The site for the new central office has not yet been selected. Initial plans are expected to provide for approximately 100 miles of cable lines.

The Study Area plus the ten-mile wide periphery presently contains 37 central offices and the following estimated amounts of lines: 836 route miles of open wire lines, 1,674 sheath miles of buried cable, and 530 sheath miles of aerial cable.

Pipeline Systems

As shown on the Utilities Data Map, there are several major transmission pipelines within the Study Area. These are listed below, along with the length of pipeline within the Study Area plus periphery.

<u>Company</u>	<u>Pipe Size (in)</u>	<u>Commodity</u>	<u>Length (mi)</u>
National Pipeline Company	6	Jet aircraft fuel	32
Lakehead Pipeline Co., Inc.	30	Crude oil	92
Northern Natural Gas Co.	2, 3, 4, 6, 8, 10 12, 16	Natural gas	138
Michigan Consolidated Gas Co.	6, 8, 10, 16	Natural gas	144
Great Lakes Gas Transmission Co.	36	Natural gas	92
Michigan Wisconsin Pipeline	30	Natural gas	9

Pipelines utilize cathodic protection to prevent corrosion. Some problems of interference between cathodic protection systems of different pipelines have been reported.

Railway Systems

There are six railroad companies in the Study Area. All provide freight services. One, the Marquette & Huron Mountain Railroad, has a short excursion line running northwest from Marquette that operates only during the summer. Their routes are shown on the Transportation Data Map, and the mileages of their lines within the Study Area plus the ten-mile peripheral region are tabulated below.

<u>Company</u>	<u>Length (miles)</u>
Chicago & North Western Transportation Company	244
Escanaba & Lake Superior	62
Lake Superior & Ishpeming Railroad Company	124

<u>Company</u>	<u>Length (miles)</u>
Chicago, Milwaukee, St. Paul, and Pacific (Milwaukee Road)	128
Soo Line Railroad Company	188
Marquette & Huron Mountain Railroad Company	10

The Milwaukee Road owns a large railroad yard in the town of Channing.

Most main routes include communications, signalling, and control circuits such as open-wire lines, automatic block signals, underground cables, and track circuits. The E&LS has no communications lines or signal lines along its tracks; all communication is by radio.

Tracks approximately one mile long are used for hauling ore in two underground iron mines (Mather and Sherwood). Vehicles are dc powered, using a trolley wire hung from the roof; the rails act as the circuit ground.

There are numerous abandoned mines in the Study Area. It is presently unknown to what extent these mines might contain abandoned rails. The Transportation Data Map shows the location of the known existing railroad systems.

Fences

Large regions within the Study Area are covered by forest and are virtually devoid of fences. Fences are usually in well defined areas of private land usually enclosing small farms. Such fences, usually three or four strands of barbed wire on wood posts, have overall lengths of a few hundred to a few thousand feet along each side. They often have interruptions due to a driveway opening and breaks caused by poor condition of repair. Although some fences are in good condition, many have wires rusted and broken and lying on the ground at frequent intervals, posts toppled and rusty wires on the ground, or bare posts standing with no wires on them.

The most substantial and significant individual fences are associated with institutions or industry; e.g., a four-strand fence (in good condition) more than two and one-half miles long on one side of K. I. Sawyer Air Force Base, a

chain-link fence along a portion of the Air Base, a chain-link fence around church grounds (approximately 0.8 mile perimeter), and fencing around numerous mining areas. Certain areas of "caving ground" are enclosed with either four-feet high mesh fences plus three strands of barbed wire, or a chain-link fence plus barbed wire on steel posts.

There are some electric fences (one or two wire strands) used to enclose farm animals, but such fences are relatively rare.

There are some short sections of snow fences, but these also are relatively rare.

Highways through hilly areas, along curves, or over streams have many bridges or exposed sections of highway protected by steel guard rails or cables. These are often on the order of 1,000 feet long.

Other Conditions

In some cases active iron mines have utility conductors up to approximately one mile long. These include power lines, telephone field wires, and water pipes (metal in some cases, plastic in others).

K. I. Sawyer Air Force Base has some single phase power distribution lines for lighting, cables in underground ducts, and a buried fuel distribution system.

There are a few skiing areas within the Study Area, some with ski lifts having long steel cables.

Several urban regions have cable TV (in addition to broadcast TV). Coaxial cable is usually strung on poles shared by other utilities.

RELATIONSHIP TO OTHER DATA

The characteristics of the utilities in the Study Area are dependent upon the nearby population centers and on the mining industry, which has been one of the major activities in the area.

The Study Area, in the western portion of the Upper Peninsula of Michigan, is largely a forested area with some agricultural regions, and six active iron mines, with an additional mine to open in 1976. There are approximately 200 inactive mines in the area.

Major population centers in the area are Marquette, Negaunee, and Ishpeming to the northeast; L'Anse to the northwest; Crystal Falls and Iron Mountain to the southwest; and Escanaba and Gladstone to the southeast. There are also many small towns.

K. I. Sawyer Air Force Base, south of Marquette, is an active base of the Strategic Air Command.

There is a strong correlation in the configuration of the transportation and utilities systems in the Study Area. Power and telephone lines commonly parallel or share railroad or rural road Rights-of-Way.

VALIDITY

The utilities systems data are primarily those of facilities location. The utilities system map was prepared from power system maps provided by Williams & Works, and from telephone, railroad and pipeline system maps provided by IIT Research Institute.

All incorporated areas of 2,000 people or more, plus a buffer zone of one mile, are excluded from the Study Area. Other areas excluded from the Study Area are the Huron Mountain Club and the McCormick Experimental Forest (Figure 1). Due to the density of data and graphic limitations, systems within the urban areas were not shown except when it was necessary for continuity.

The power systems data tabulated and delineated in this document was gathered by personal visits by Williams & Works' personnel to all the various power companies providing electrical utility service within the Study Area. Maps were obtained from Upper Peninsula Power Company, Wisconsin Michigan Power Company, Crystal Falls Electric and Water Department, Marquette Board of Light and Power, Ontonagon County Rural Electrification Association and Alger Delta Cooperative Electrical Association. The data were obtained in December 1975.

Telephone systems maps were obtained from Michigan Bell Telephone Company, General Telephone Company of Michigan, Midway Telephone Company, Baraga Telephone Company, Chatham Telephone Company, and Upper Peninsula Telephone Company. Many of the data were obtained in 1974 and updated to January 1976.

Pipeline routes of Lakehead Pipeline Company, Northern Natural Gas Company and Great Lakes Gas Transmission Company were obtained from maps furnished by those companies. Routes for National Pipeline Company, Michigan Consolidated Gas Company, and Michigan Wisconsin Pipe Line Company were obtained from pipeline atlases published by the Oil and Gas Journal and from supplemental information. Due to the small scale of these maps, the data accuracy is uncertain.

The existing railroad lines shown on the Transportation Data Map were taken from the Department of Natural Resources' County Base Map. The Department updated the map in 1974. These lines were checked against the 1975 Official Railroad Map of the State of Michigan.

Fence information was obtained by a visual survey along approximately 600 miles of U. S. and state highways and county roads in the Study Area. Because no reliable maps of fence locations were available, this data category was not added to the Utilities Data Map.

The accuracy of the Utilities Data Map depends on the quality of the original maps which varied considerably in scale, detail, and accuracy.

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APPENDIX A
MAJOR SUBSTATIONS
IN THE STUDY AREA

Source: Williams & Works
March 5, 1976

TABLE 1 - MAJOR SUBSTATIONS DATA - UPPER PENINSULA POWER COMPANY

Name	Location	No. of Transformers	No. of Circuits	Voltages		No. of Feeders	Size of Feeders
				Pri.	Sec.		
BARNUM	ISHPEMING	1-6 MVA 3 Ø	1	33KVΔ		1-Ishpeming Steam Plant	#2/0 CU
		1-5 MVA 3 Ø	6		7.2/ 12.5KV X ₁	1-Junction 2-Ely 3-Barnum 4-Deer Lake 5-Alpine 6-Viking	
CLIFFS SHAFT	ISHPEMING	3-1.25 MVA 1 Ø	1	33KVΔ		1-Ishpeming Steam Plant	#2/0 CU
CEDAR	ISHPEMING		2	33KV X ₁	2.4KVΔ	1-Cliff Shaft	-
			2			1-Ishpeming Steam Plant	#4/0 ACSR
		1-15 MVA 3 Ø Auto Trans	2		69KV X ₁	2-Gwinn	#336 MCM ACSR
			1	69KV X ₁		1-Humboldt Mine	#336 MCM ACSR
MATHER "B"	MATHER MINE	1-50 MVA 3 Ø Auto Trans	4			2-Gwinn	#336 MCM ACSR
			2	33KV Y		1-Ishpeming	#2/0 CU
			1			2-Steam Plant	#2/0 CU
			2	33KVΔ	2.4KVΔ	1-Mather "B"	-
NEGAUNEE	NEGAUNEE	3-1 MVA 1 Ø	2			1-Ishpeming	#2/0 CU
TRACY MINE	TRACY MINE	2-75KVA 1 Ø Open Delta	1	33KVΔ	4.16KVΔ	2-Steam Plant	#2/0 CU
LAKESHORE		3-167 KVA 1 Ø	1	33KVΔ	2.4KVΔ	1-Negaunee	#2 Solid CU
WLUC - TV	WLUC - TV ELY TWP.	1-75 KVA 1 Ø 1-25 KVA 1 Ø Open Delta	2	33KVΔ	480V X ₁		#2 Solid CU
FREEMAN	FREEMAN	1-25 MVA 3 Ø Auto Trans	4	33KVΔ	2.4KVΔ		#2 Solid CU
			2			1	#2 Solid CU
			2			2	#2 Solid CU
			2			3	#2 Solid CU
			2			4	#2 Solid CU
			2			1	#2 Solid CU
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			2			4	#2 Solid CU
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			2			3	#2 Solid CU

TABLE 1 - Major Substations Data - Upper Peninsula Power Company - Continued

Name	Location	No. of Transformers	No. of Circuits	Voltages		No. of Feeders	Size of Feeders
				Pri.	Sec.		
LINDBERGS		3-200 KVA 1 Ø	1	33KVΔ		1	#2 Solid CU
ROBE RIVER		3-400 KVA 1 Ø	1	33KVΔ	2.4KVΔ	1-Lindbergs	Cust. Bus
EAGLE MILLS	EAGLE MILLS	3-1667 KVA 1 Ø	1	33KVΔ	2.4KVΔ	1	#336 MCM ACSR
GWINN	GWINN	3-1.25 MVA 1 Ø	1	33KVΔ	2.4KVΔ	1	Cust. Bus
			4	33KVΔ	69KVΔ	1-Cedar Sub	#336 MCM ACSR
						1-KI Sawyer	#1/0 ACSR
						2-Munising	#3/0 ACSR
M-38	M-38 ROAD AT GRIST-MILL ROAD (DETAILED MAPS SHOW ROAD AS M-35)	1-3.75 MVA 3 Ø	1	69KVΔ		3-Cedar	#336 MCM ACSR
			1	69KVΔ		4-Forsyth	#336 MCM ACSR
			2	69KVΔ	12.5KVΔ	Bus	
FALLS RIVER	L'ANSE	1-2.5 MVA 3 Ø	1	13.8KVΔ		1-Atlantic Sub	#4/0 ACSR
			1	13.8KVΔ		2-Warden StmPInt	#4/0 ACSR
			2	13.8KVΔ		1-Baraga	#1 Solid CU
L'ANSE	L'ANSE	3-667 KVA 1 Ø Auto Trans (3-333 KVA 1 Ø) Grd Trans	1	13.8KVΔ	12.5KVΔ	2-Alston-Pelkie	#2 CU
			1	13.8KVΔ	4.16KVΔ	3-Prickett Hydro	#2 CU
			2	13.8KVΔ	12.5KVΔ	1-Warden StmPInt	#1/0 ACSR Ø
K.I. SAWYER	K.I. SAWYER	2-5 MVA 3 Ø	1	69KVΔ		1-L'Anse Area	#2/0 ACSR
			1	69KVΔ		2-L'Anse Area	4 Sol CU
			1	69KVΔ	12.5KVΔ	1-Gwinn	#1/0 ACSR
FORSYTH	FORSYTH	1-50 MVA 3 Ø Auto Trans	1	138KVΔ	69KVΔ	1-K.I. Sawyer	Cust. Bus
			2	138KVΔ	69KVΔ	1-Empire Mine	#605 MCM ACSR
			1	69KVΔ	33KVΔ	1-Gwinn	#336 MCM ACSR
CLARKSBURG	CLARKSBURG	3-1333 KVA 1 Ø	1	69KVΔ		2-Escanaba	#336 MCM ACSR
			1	69KVΔ		1-Cedar	#2 CU
HUMBOLDT MINE	HUMBOLDT MINE	2-7.5 MVA 3 Ø	2	69KVΔ		1-Ohio Mine	#336 MCM ACSR
			1	69KVΔ		1-Clarksburg	#1/0 ACSR
			1	69KVΔ	2.4KVΔ	2-Humboldt Mine	Cust. Bus

TABLE 1 - Major Substations Data - Upper Peninsula Power Company - Continued

Name	Location	No. of Transformers	No. of Circuits	Voltages		No. of Feeders	Size of Feeders
				Pri.	Sec.		
NORTH ELECTRIC AUTOMATIC FDRY	Sec 1, T47N, R28W ELY TWP.	1-22.5 MVA 3 Ø	1	69KV½		1-Cedar Sub	#170 ACSR
			1		13.8KVΔ	1-Cust.	Cust. Bus
			1	69KVΔ		1	#170 ACSR
EMPIRE MINE RICHMOND TWP.		4-30 MVA 3 Ø	3	138KV½	480V	1-Cust.	Cust. Bus
						1-National Sub	#605 MCM, ACSR
						2-Forsyth Sub	#605 MCM, ACSR
						3-U.P. Gen Co	#605 MCM, ACSR
NATIONAL	TILDEN TWP.	None	4		13.8KVΔ	1-Mine	Cust. Bus
						2-Mine	Cust. Bus
						3-Mine	Cust. Bus
						4-Mine	Cust. Bus
TILDEN		2-50 MVA 3 Ø	6	138KVΔ	-	1-Cedar Sub	#605 MCM, ACSR
						2-U.P. Gen Co	#605 MCM, ACSR
						3-Perch Lake	#605 MCM, ACSR
						4-Tilden Sub	#605 MCM, ACSR
						5-Tilden Sub	#605 MCM, ACSR
						6-Empire Sub	#605 MCM, ACSR
PERCH LAKE	CHAMPION TWP.	1-5 MVA 3 Ø	2	138KVΔ		1-National Sub	#605 MCM, ACSR
			2		13.8KVΔ	2-National Sub	#605 MCM, ACSR
			3	138KV½		2-Mine	-
REPUBLIC MINE SOUTH OF REPUBLIC C		1-30 MVA 3 Ø				1-Republic	#605 MCM, ACSR
						2-National Sub	#605 MCM, ACSR
						3-WMP Co	#605 MCM, ACSR
						1-Republic Dist	#170 ACSR
PIONEER		1-20 MVA 3 Ø	1	138KV½		1-Perch Lake	#605 MCM, ACSR
			1		13.8KVΔ	1-Mine	-
			2		138KV½	Bus	-
					13.8KVΔ 2.4KVΔ	1-Distribution 1-Distribution	- -
		1-20MVA 3 Ø	1	138KV½		1-Cust.	#336 MCM, ACSR Cust. Bus

Note: UPP Co has one mobile substation for emergency use.

TABLE 2 - MAJOR SUBSTATIONS DATA - WISCONSIN MICHIGAN POWER COMPANY

Name	Location	No. of Transformers	No. of Bushings	No. of Circuits	Voltages		No. of Feeders	Size of Feeders
					Pri.	Sec.		
ARMORY	KINGSFORD, MI	1-10 MVA 3 Ø	3 HSA 4 LSY	1	69KV	13.8KV	4	#336 MCM ACSR 2 #336 MCM ACSR 2 #2/0 Cu
BASS LAKE	IRON MOUNTAIN CITY	1-10 MVA 3 Ø	3 HSA 4 LSY	1	69KV	13.8KV	5	#336 MCM ACSR 3 #336 MCM ACSR #2/0 ACSR #2 ACSR
BRUCE CROSSING	STANNARD TWP. ONTONAGON CO.	1-3 MVA 3 Ø	3 HSA 3 LSA	2	69KV	13.8KV	3	#2/0 & #1/0 ACSR 2 #336 MCM ACSR and #2/0 ACSR
CHALKHILL- SPAULDING	HOLMES TWP.	1-7.5 MVA 3 Ø	3 LSA	1	2.4KV			Station Bus
CHAMPION	CHAMPION TWP.	6-500 KVA 1 Ø in 2-3 Ø Banks	4 HSA 2 LSA		34.5KV	69KV	1	#2/0 ACSR Cust Bus
CORNELL	CORNELL TWP.	1-7.5 MVA 3 Ø	3 HSA 3 LSA	(All Delta) 1	69KV	13.8KV	1	#336 MCM ACSR #336 MCM ACSR
CRYSTALL FALLS	CRYSTAL FALLS TWP.	3-2 MVA 1 Ø	2 HSA 2 HSY	3	69KV	12.47KV	3	2 #2/0 ACSR and #1/0 ACSR #2/0 Cu Strd
FELCH	FELCH TWP.	3-420 KVA 1 Ø	2 HSY 2 HSA	1	69KV	13.8KV	2	2 #2 Cu Strd and #336 MCM ACSR
GREDE*	KINGSFORD CITY	3-2.5 MVA 1 Ø	2 HSA 2 LSA	1	69KV	13.8KV	1	2 #2 ACSR #2/0 ACSR Cust Bus
GROVELAND MINE* HARRIS	FELCH TWP. HARRIS TWP.	CUSTOMER OWNED @ BUS - MINE HAS A 35 MM LOAD ON WMP CO. 1-6 MVA 3 Ø	4 HY 3 LA	1	69KV	13.8KV	3	#336 MCM ACSR 2 #2/0 ACSR and #336 MCM ACSR
IRON MOUNTAIN EAST SIDE	IRON MOUNTAIN CITY	1-1.5 MVA 3 Ø	3 HA 4 LY	1	13.8K	4160V	2	#336 MCM ACSR #2/0 Cu Strd and #336 MCM ACSR
IRON RIVER	IRON RIVER CITY	3-2.5 MVA 1 Ø	2 HA	4	69KV			2 #4/0 ACSR and #2/0 ACSR and #336 MCM ACSR
KINGSFORD METALS	BREITUNG TWP.	3-2.5 MVA 1 Ø	2 LA 2 HA 2 LA	1	69KV	7.2KV 4160V	4 1	4 #2/0 Cu Strd #2/0 ACSR Cust Bus

* Customer Owned

TABLE 2 - Major Substations Data - Wisconsin Michigan Power Company - Continued

Name	Location	No. of Transformers	No. of Bushings	No. of Circuits	Voltages		No. of Feeders	Size of Feeders
					Pri.	Sec.		
LAKEHEAD * PIPELINE (GAS) LAND-O-LAKES	IRON RIVER TWP.			1	69KV			#3/0 ACSR
	WATERSHEET TWP.	1-3.75 MVA 3 Ø	3 HΔ 4 LΔ	1	69KV	4160V	1	Cust. Bus #2/0 ACSR
	GREENLAND TWP.	3-500 KVA 1 Ø	2 HΔ 2 LY	1	69KV	13.8KV	3	#2/0 ACSR #1/0 ACSR
NORDIC				Plus UPPCo interconnec- tion normally open (69KV)		12.47KV	1	#2/0 ACSR
	FELCH TWP.	1-150 MVA 3 Ø	4 HV	2 one from UPP Co, one from WMP Co	138KV		1	#795 MCM ACSR (WMP) (UPP Co)
PLAINS	BREITUNG TWP.	2-50 HVA 3 Ø	4 LY 4(138)Y 4 Ø	138KV		69KV	2	2 #336 MCM ACSR 2 #4/0 ACSR and #795 MCM ACSR
			4(69)Y			69KV	5	3 #4/0 ACSR 2 #1/0 Cu Strd
	SAGOLA TWP.	1-1 MVA 3 Ø	3(13.8)Δ 3 HΔ	2 one of which is normally open	69KV	13.8KV	2	2 #2/0 Cu Strd 1 #2/0 Cu Strd 1 #336 MCM ACSR
SPALDING	SPALDING TWP.	1-5 MVA 3 Ø	3 LΔ 3 HΔ 3 LΔ	1	69KV	13.8KV	2	2 #1/0 ACSR #2/0 ACSR
						13.8KV	3	2 #336 MCM ACSR and #1/0 Cu Strd
TWIN LAKE		1-3.75 MVA 3 Ø	3 HΔ 3 LY	1	69KV	13.8KV	3	#2/0 ACSR 2 #2/0 ACSR and #336 MCM ACSR
WATERSHEET	WATERSHEET TWP.	3-500 KVA 1 Ø	2 HΔ 2 LY	1	69KV	12.47KV	3	#2/0 ACSR 2 #2/0 ACSR and #336 MCM ACSR
STRAWBERRY HILL		1-3.75 MVA 3 Ø	3 HΔ 4 LY	1	69KV	13.8KV	3	#3/0 ACSR 2 #336 MCM ACSR and #4/0 ACSR

* Customer Owned
Not in area

Note: WMP Co has four mobile substations on flat beds used in emergencies. Voltages are extremely flexible for use in the system up to 69 KV

TABLE 3 - MAJOR SUBSTATIONS DATA - MARQUETTE BOARD OF LIGHT AND POWER

Name	Location	No. of Transformers	No. of Circuits	Voltages		No. of Feeders	Size of Feeders
				Pri.	Sec.		
#2 HYDRO	AT HYDRO #2 STATION	2-2240 KVS 1 Ø Scott Conn.		7200V 2 Ø ungrounded			
#3 HYDRO	AT HYDRO #3 STATION	3-333 KVA 1 Ø	2		12.5KV 3 Ø grounded	#5H Hydro Tie	#336.400 ACSR Aluminum
#4 DIESEL	AT DIESEL #4 STATION	3-3000 KVA 1 Ø Trans Bank #1	1	2400V Delta 3 Ø		Hydro Tie	#336.400 ACSR Aluminum
			Trans Bus	2400 V Delta 3 Ø	12.5KV Delta 3 Ø		
			5		12.5KV Wye 3 Ø grounded	Hydro Tie #3 Circuit * #4/0 CU #1/0 CU Bus	#336
		1-12.5 MVA 3 Ø Trans Bank #2	1	12.5KV Delta 3 Ø			
			2		69KV Wye 3 Ø grounded	69KV Marquette Line	#605 MCM ACSR
						69KV Diesel Line	
#5 SHIRAS STEAM PLANT	AT STEAM PLANT	1-33 MVA 3 Ø Trans Bank #1	1	12.5KV Wye 3 Ø grounded			
		No Transformers	1		69KV Delta 3 Ø	69KV Diesel Line	#605 MCM ACSR
			6		12.5KV	1-South Rural 2-#1 Circuit 3-#3 Circuit 4-WW Circuit 5-#5 Circuit 6-Trans Bank #1	

* Alger Delta Big Bay Sub (south) is connected to this circuit.

TABLE 4 - MAJOR SUBSTATIONS DATA - ONTONAGON COUNTY RURAL ELECTRIFICATION ASSOCIATION

Name	Location	No. of Transformers	No. of Circuits	Voltages		No. of Feeders	Size of Feeders
				Pri.	Sec.		
AURA	SW 1/4 of the SW 1/4 Sec 19 T51N R33W	3-167 KVA 1 Ø	1	12.5KVX ₂			#1/0 ACSR
			1		7.2/ 12.5KV	1	#1/0 ACSR
HERMAN	NW 1/4 of the SW 1/4 Sec 22 T50N R33W	No Transformers Meter Station	1	7.2KV			
		1 Ø	1		7.2KV	1	#8A
PECKIE	SW 1/4 of the NE 1/4 Sec 27 T51N R34W	2-75 KVA 1 Ø	1	69KV		1	#8A
			2		7.2KV	2	#8A

TABLE 3 - MAJOR SUBSTATIONS DATA - ALGER DELTA COOPERATIVE ELECTRIC ASSOCIATION

Name	Location	No. of Transformers	No. of Circuits	Voltages		No. of Feeders	Size of Feeders
				Pri.	Sec.		
HADEAU 42'-0" x 76'-6" FENCED ENCLOSURE	NEAR HADEAU; SW CORNER SEC. 3; T37N, R26W	3-250 KVA Westinghouse 3-Spares	1	13,800	7,200/ 12,470	1	3-#2/0 ACSR* #6A
MAPLE RIDGE POLE TYPE	NEAR ROCK ON CR432	3-167 KVA Westinghouse No spares	2	from 14M	Ground Y Same as Above	2	#6A
WHITE RAPIDS GROUND TYPE	NE CORNER; SEC. 31; T36N, R28W	3-333 KVA - GE 1-333 KVA Spare GE Double Bushing	1	2,400 V from 14M	7,200/ 12,470 Ground Y	1	3-#2/0 ACSR* 2-#ACSR
LAFAYETTE	NE CORNER, SEC. 33 T40N, R26W	2-75 KVA 1-75 KVA (Spare) 2-Regulators	1	13,800 from 14M	7,200/ 12,470 Ground Y	1	3-#2/0 ACSR* 2-#6A 1-#6A
GOURLY	ADJACENT TO CR551 SEC. 14; T38N, R25W SW CORNER OF SW 1/4 FENCE ENCLOSURE (56' (NS) x 49'-6" (EW)) GROUND GRID AROUND FENCE	3-667 (Porter Electric) 1-667 KVA Spare (Porter Electric)	1	13,800 from 14M	7,200/ 12,470 Y 14,400/ 24,900 Y	1	3-#2 ACSR* 3-#4/0 ACSR 1-#1/0 ACSR
BIG BAY, (SOUTH)	SW 1/4 of SE 1/4 OF SW 1/4, SEC. 10; T48N, R25W; 25 MI. SE OF BIG BAY, POLE TYPE	2-333 KVA auto transformer by Kuhlman 1-333 KVA (Spare) 2-38.1 Regulators	1	7,200/ 12,470 Y Ground from MP	14,400/ 24,900 Ground Y	1	2-#4/0 ACSR**
BIG BAY, (NORTH)	CENTER OF SEC. 26 T51N, R27W	2-333 KVA Auto Transformer Pole Mtd. Triple Bushing	1	14,400/ 24,900 Ground Y	7,200/ 12,500 Ground Y	1	2-#4A 1-#2 ACSR
HARVEY	JUNCTION OF US-41 AND M-28 AT HARVEY	3-57.2 KVA 1 Ø Regulators	1		7.2/ 12.5KV Ground Y	1	3-#1/0 ACSR 1-#2 ACSR

* See 14M

** See MP

